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厦门大学

硕 士 学 位 论 文

基于专利知识分析的机械产品概念设计技术研究与应用

Research on the Conceptual Design of Mechanical Products Based on Patent Knowledge Analysis and its Application

陈 明 民

指导教师姓名：侯 亮 教授
专 业 名 称：机械制造及自动化
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摘 要

专利文献中含有超过 80%的人类科学知识，可以提供大量的用于创新设计的技术知识和启发原理，对专利的不断研究和应用价值非常巨大。近年来，随着市场全球化和专利制度的规范化，专利等知识产权已经被越来越多的企业所重视，充分挖掘和利用专利信息有助于技术人员进行新产品开发。然而现阶段企业设计部门对专利的利用局限于简单的大量下载和人工阅读理解，这种方式无法实现专利的有效管理和信息分享，造成效率低下。

本文结合制造企业产品研发创新特点，对专利知识提取和应用技术进行研究，并开发了相应的专利辅助创新系统工具。主要研究工作和结论如下：

研究了机械产品专利分析及概念设计过程模型，并分析其关键技术，包括专利知识建模技术、基于专利的规避设计技术和基于功能-效应-结构求解模型的组合设计技术。

针对专利文献的特殊格式，描述了其结构类型及专利说明书的具体形式；建立由专利基本信息库、专利原理方案库、特定产品参数知识库和设计需求知识库组成的专利知识体系；提出机械产品性能、功能和效应表达方法；采用光学字符识别（Optical Character Recognition，OCR）技术和“功能-效应-结构”知识映射模型，提出专利信息表达树状模型，为实现专利信息的自动获取和辅助创新设计奠定了良好的基础。

为了实现专利信息的有效利用，提出一种专利知识启发的概念创新设计方法，构建专利知识辅助创新设计过程模型，提出基于功能和性能目标的专利检索方式，以专利知识库为基础，探讨基于现有专利的规避设计和基于形态分析的功能-效应-结构组合设计两种产品概念创新策略，最后以工程机械行业产品创新设计为例说明方法的可行性，并验证该方法能有效提高产品概念创新能力。

以前述章节理论研究为基础，开发了计算机辅助专利分析和产品概念创新设计系统（Computer Aided Conceptual Design based on Patent， PCACD）V1.0，介绍 PCACD 系统的设计需求和开发环境，提出由专利管理、创新设计和产品参数三大主要模块组成的软件系统总体框架，对关键功能模块进行实现，结合企业应用具体说明了 PCACD 系统主要界面及操作过程，并用装载机湿式制动器设计实例说明系统的良好应用。

关键词：专利；概念创新设计；知识表达和存储；计算机辅助设计；工程机械

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ABSTRACT

Patent literature, containing more than 80% of human scientific knowledge, can provide a lot of technical knowledge and inspiration principle for innovative design, the value for continuous research and application of patent is very large. In recent years, with the globalization of markets and the further standardization of the patent, patent and other intellectual property has been respected by more and more enterprises, fully tap and use of patent information can help technical staff for new product development. However, at the present stage the use of patent limited to a large number of simple download and manual analysis in corporate design departments, and in this way the patent can not be achieved to the effective management and information sharing, resulting in inefficient.

In this paper, combining the R&D characteristics of manufacturing companies, the patent knowledge extraction and application technology were researched, and the patent supporting innovation system tools was developed. The research work and conclusion were as follows:

The patent analysis and conceptual design process mode of mechanical products was constucted, and its key technologies, including the patent knowledge modeling technology, the design around based on patent and the combination design based on function-effect-structure solving model were discussed.

Aiming at the special format, the structure of patent documents and the form of specifications was analyzed; a patent knowledge base contained basic information library, principle scheme library, parameters library and requirements library was established; the expressions of mechanical product performance, function and effect were proposed; using optical character recognition technology and "function-effect-structure" knowledge mapping model, the expression tree model of patent information was presented; it has laid a good foundation to achieve the automatic access to patent information and support innovative design.

In order to achieve the effective use, an innovative conceptual design method inspired by patent knowledge was studied; the patent supporting innovative design

process model was constructed; a patent search method based on function and performance was proposed; basis of the patent knowledge base, the design around based on existing patent and the function-effect-structure design based on morphological analysis were discussed. Finally, take construction machinery industry products for an example to show the method's feasibility and can effectively improve the product concept innovation.

According to the previous sections research, the computer aided concept design based on patent (PCACD) V1.0 was developed. The design requirements and development environment was introduced; the software system framework composed by patent management module, innovative design module and product parameters module was presented; and the key functional modules was implemented; the main interfaces and operating process were illustrated; finally, take the design of loader wet brake as a case to show the good applications of this system.

Keywords: Patents; Conceptual Design; Knowledge express and Store;
Computer-aided Design; Construction Machinery

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